PATENT SPECIFICATION 1,036,464

DRAWINGS ATTACHED.

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COMPLETE SPECIFICATION.

An Inverter Arrangement.

We, LICENTIA PATENT - VERWALTUNGS-G.M.B.H., of 1 Theodor-Stern-Kai, Frankfurt am Main, West Germany, a German Body Corporate, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to an inverter for the supply of alternating current to a load. It is known to produce alternating voltages from direct current by means of inverters. By using, for example, three individual inverters, which are fed from the same direct-current source, it is also possible to build up a normal three-phase system with a phase displacement of 120°. The inverters used for this purpose merely act as switches and form from the direct voltage a rectangular-wave alternating voltage. If a sinusoidal output voltage is required, then additional filter means must be used.

This known arrangement has certain disadvantages: The inverter works at the frequency required for the load. If this happens to be a relatively low frequency (for example 50 c.p.s.), then the filter means necessary to produce a sinusoidal voltage are extremely large. If the frequency is to be varied, then appropriate intervention in the control of the circuit elements contained in the inverter is necessary. When the frequency of these known inverters is varied, however, the amplitude of the rectangular-wave voltage remains unaltered because the switches merely continuously reverse the polarity of the voltage from the direct-current source. As a result, difficulties arise when the load consists of an iron inductance (for example an alternating-current motor, a shaking drive for a conveyor, a magnetic amplifier). It is known that for economic and space-saving reasons, such consumer devices are so designed that the induction in the iron has a maximum value which is limited by the saturation and the iron losses. This induction only remains constant as long as the ratio of the height of the feed voltage to the frequency of the feed voltage remains constant. Thus if an alternating-current motor, for example, is fed through an inverter of the known type, this motor is no longer fully utilized when the feed frequency is increased because the voltage of this inverter remains constant.

It is the object of the present invention to overcome the mentioned drawbacks in the known inverter.

The invention consists in an inverter arrangement for the supply of alternating current to a load from a direct-current source, comprising an inverter which supplies a succession of alternating positive and negative current pulses with a pulse repetition frequency higher than the frequency of the desired alternating current and with such relationship in the pulse widths of successive pulses that positive pulses predominate in one half-period and negative pulses predominate in the other half-period of the frequency of the desired alternating current so that the mean value of the output voltage varies sinusoidally.

The invention will be explained in more detail with reference to Figures 1 to 3 of the accompanying drawing.

As shown in Figure 1, an inverter is fed from a direct voltage source 2. Its output voltage U_a is supplied to a load 3 through filter means which consist of a series inductor 4 and a shunt capacitor 5 in the example. The load 3 is represented in the example as an inductive load and may be a stator winding of an induction motor for example. The inverter 1 works at a frequency which is con-

siderably higher than the frequency necessary for the inductance 3 to be fed. So long as the commutating switches contained in the inverter 1 operate in the usual manner, the rectangular-wave voltage illustrated in Figure 2*a* is obtained as an output voltage U_a. The area within the positive and negative blocks of half-waves is constant. Since the frequency of this rectangular-wave voltage U_a is very high, the total voltage drops at the series-connected inductor 4, while the inductance 3 is practically short-circuited by the capacitor 5 in respect of the high frequency. Thus no voltage reaches the inductance 3.

According to the invention, the mean value of the output voltage U_a is varied sinusoidally by means of a periodic modulation of the pulse length. The positive and negative blocks of half-waves of the output voltage U_a are now no longer equal in size but vary in accordance with a sine function. A low-frequency voltage U^1_a is thus superimposed on the high-frequency voltage U_a (Figure 2*b*). The inductance 4 does not represent any obstacle to the passage of this low-frequency voltage, while the capacitor 5 can be regarded as absent in view of its high reactance. Thus the low-frequency voltage is applied to the load 3. If the cycles at which the pulse-length modulation fluctuates are varied, then the frequency of the voltage applied to the load 3 also varies.

The magnitude of the low-frequency output voltage can be varied by a variation of the relation between the the pulse widths of two successive pulses, that is to say the ratio of t_1 to t_2 (Figure 2*b*) varies to a greater or lesser extent. Thus the amplitude of the lower harmonic voltage U^1_a can be varied although the amplitude of the output voltage U_a of the switching inverter remains unaltered. For example, if it is desired to ensure that an iron inductance to be fed shall be operated always with the same induction despite variation in the frequency of the supply voltage, it is only necessary to ensure that the amplitude of the resulting alternating current and its frequency are varied simultaneously in such a manner that the quotient of amplitude and frequency of the resulting alternating current remains substantially constant. Ultimately, of course, only the ratio of t_1/t_2 is adjustable in the actual inverter; for both the frequency and the amplitude of the resulting alternating current are determined by the ratio t_1/t_2. The action is, as it were, that the ratio t_1/t_2 is controlled by a sinusoidal alternating voltage. Where the momentary value of this alternating voltage is zero, the ratio t_1/t_2 has the value one. By presetting the frequency of this alternating voltage at the input 1*f*, the frequency of the resulting alternating current is varied, and by presetting the amplitude of this alternating voltage at the input 1*a*, the amplitude of the resulting alternating current is varied.

If it is desired to operate an inductive load, for example an alternating-current motor, in such a manner that, regardless of the frequency, the utilization of the iron always lies at the limit imposed by the saturation, then the intensity of the periodic fluctuations in pulse length can be controlled depending on the input motor current in such a manner that this current does not lose its sinusoidal form, but does assume the highest possible value.

As is known, the deviation of the motor current from the sinusoidal form only occurs when the iron is excessivley saturated. This means, however, that the induction is exceeding admissible values. Therefore, the deviation in the load current from the sinusoidal form may be ascertained and the quantity describing this deviation may be applied as an additional control to the input 1*a* of the inverter, which in itself is already fully controlled and through which the intensity of the periodic fluctuations in pulse length can be adjusted. This part of the arrangement is shown in broken lines in Figure 1. The load current is detected at the point 6 and a quantity describing the deviation in the load current from the sinusoidal form is formed in the member 7. This quantity is applied to the input 1*a*.

WHAT WE CLAIM IS:—

1. An inverter arrangement for the supply of alternating current to a load from a direct-current source, comprising an inverter which supplies a succession of alternating positive and negative current pulses with a pulse repetition frequency higher than the frequency of the desired alternating current and with such relationship in the pulse widths of successive pulses that positive pulses predominate in one half-period and negative pulses predominate in the other half-period of the frequency of the desired alternating current so that the mean value of the output voltage varies sinusoidally.

2. An inverter arrangement as claimed in claim 1, comprising a control device designed to vary the length of successive half-periods in which positive pulses and in which negative pulses predominate in order to vary the frequency of the resulting alternating current.

3. An inverter arrangement as claimed in claim 1 or 2, comprising a control device designed to vary the ratios between the pulse widths of successive pulse pairs in order to vary the amplitude of the resulting alternating current.

4. An inverter arrangement as claimed in claim 2 and 3, wherein the frequency and the amplitude of the resulting alternating current are varied in such a manner that the quotient of amplitude and frequency of the resulting

alternating current is substantially constant.

5. An inverter arrangement as claimed in claims 3 or 4, comprising a device for ascertaining deviations of the resulting alternating current from its sinusoidal form and for producing a corresponding control signal which is supplied to the inverter control device so as to obtain substantially full utilisation of the iron of an inductive load.

6. An inverter arrangement as claimed in any one of the preceding claims comprising filter means between the inverter and the load which filter means prevent the passage of the pulses of the said higher repetition frequency and allow to pass the sinusoidal alternating current of lower frequency.

7. An inverter arrangement substantially as described with reference to and as illustrated in the accompanying drawing.

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1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

Fig. 1

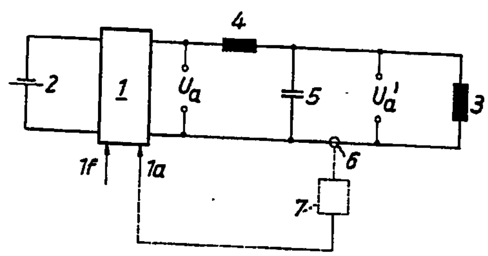

Fig. 2a

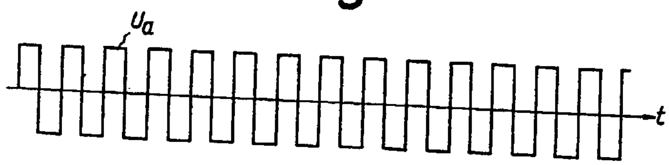

Fig. 2b